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FOREST PEST MANAGEMENT REPORT

RELEASE OF DIPEL 4L FOR CONTROL OF SPRUCE BUDWORM

NICOLET NATIONAL FOREST, 1981

A post-suppression evaluation

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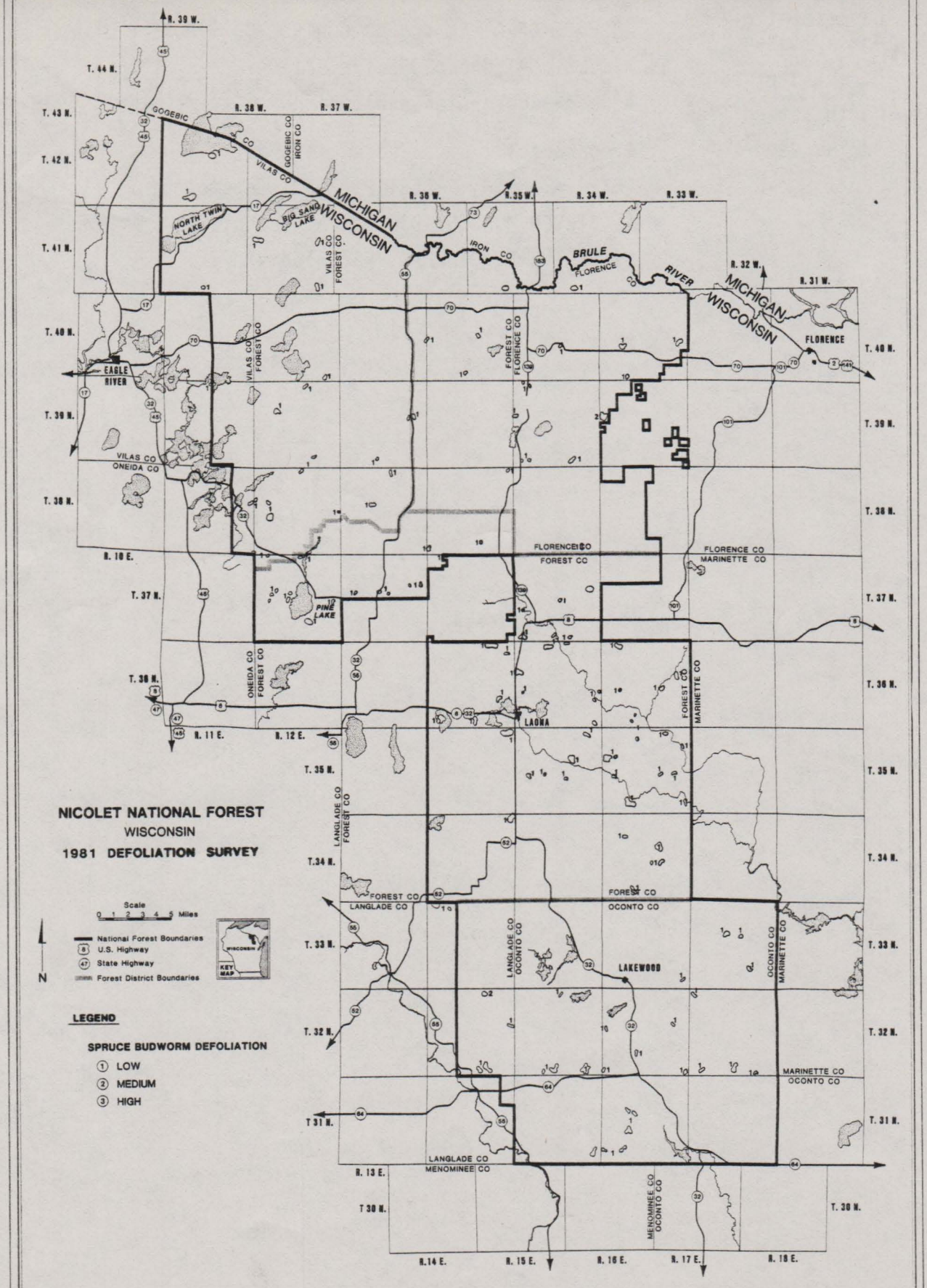
NICOLET NATIONAL FOREST
WISCONSIN
1981 DEFOLIATION SURVEY
Scale
0 1 2 3 4 5 Miles
National Forest Boundaries
U.S. Highway
State Highway
Forest District Boundaries
KEY MAP
N
LEGEND
SPRUCE BUDWORM DEFOLIATION
1 LOW
2 MEDIUM
3 HIGH
R. 39 W.
R. 38 W.
R. 37 W.
R. 36 W.
R. 35 W.
R. 34 W.
R. 33 W.
R. 32 W.
R. 31 W.
R. 10 E.
R. 11 E.
R. 12 E.
R. 13 E.
R.14 E.
R. 15 E.
R. 16 E.
R. 17 E.
R. 18 E.
T. 44 N.
T. 43 N.
T. 42 N.
T. 41 N.
T. 40 N.
T. 39 N.
T. 38 N.
T. 37 N.
T. 36 N.
T. 35 N.
T.34 N.
T. 33 N.
T. 32 N.
T 31 N.
T 30 N.
GOGEBIC CO
VILAS CO
IRON CO
MICHIGAN
WISCONSIN
NORTH TWIN LAKE
BIG SAND LAKE
BRULE
FLORENCE
RIVER
FLORENCE
EAGLE RIVER
ONEIDA CO
PINE LAKE
LAONA
LAKEWOOD
FOREST CO
FLORENCE CO
MARINETTE CO
LANGLADE CO
OCONTO CO
MENOMINEE CO

INTRODUCTION

The current spruce budworm, Choristoneura fumiferana (Clemens), outbreak began in 1976 on the Nicolet National Forest in the vicinity of Three Lakes, Wisconsin. Expansion and itensification of the outbreak has occurred primarily in a northward direction, but there are also a few small isolated areas of infestation to the south and east of Three Lakes (Ford and Hastings 1980) Figure 1.

Losses due to this outbreak now exceed 135,000 cords (489,000 m^3) and considerably more trees (over 150,000 cords or 543,000 m^3) are damaged and dying. The bulk of these losses has been in balsam fir, Abies balsamea (L.) Mill., pulpwood stock, of which about 50 percent has been salvaged. That which has not been salvaged is either inoperable because of stand size, is inaccessible, or is in areas protected because of their wilderness status.

Even though most of the losses are in balsam fir, stands of white spruce, Picea glauca (Moench) Voss, and stands containing eastern hemlock, Tsuga canadensis (L.) Carr., have also been affected. There was concern for these spruce and hemlock stands because of their high value and/or their special interest or recreational uses. This concern prompted the Timber Staff Officer of the Nicolet National Forest to request a biological evaluation of the spruce budworm situation in selected high value stands. This evaluation was conducted by Forest Pest Management personnel during September and October 1980.

Evaluation criteria included egg mass counts, defoliation levels, tree vigor and condition, and the relative abundance of empty pupal cases. The results and recommendations of the evaluation (Ford and Hastings 1980) suggested an integrated management approach using thinnings, delaying release cuttings, presalvage of damaged fir stands, encouragement of mixed stand composition, and the application of Bacillus thuringiensis (B.t.) in selected high value white spruce and hemlock stands.

After weighing factors contained in the biological evaluation, the environmental assessment, and the economic evaluation, the Forest Supervisor decided to suppress spruce budworm populations using Dipel® 1/ 4L, the B.t. formula produced by Abbott Laboratories.2/ The material was released May 30 and 31, 1981, on selected stands of the Nicolet National Forest in Oneida, Vilas, and Forest Counties.

1/ Dipel is the registered trade mark of Abbott Laboratories.

2/ The use of trade, firm or corporation names is for the information and convenience of the reader. Such use does not constitute an an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others which may be suitable.

OBJECTIVE

The objective of this project was to use an aerial release of Dipel 4L in selected high value stands of hemlock and white spruce on the Nicolet National Forest to prevent excessive defoliation of the trees by spruce budworm. The criteria for success of the project were:

1. Save 60 percent or more of 1981 foliage.
2. Reduce sample population of spruce budworm larvae to no more than 0.5 larva per 15 inch (38 cm) branch tip on hemlock and 1 larva per 15 inch (38 cm) branch tip on white spruce, measured 14 days after Dipel 4L is applied.

MATERIALS AND METHODS

The treatment consisted of one application of B.t. at a rate of 8 billion international units in one gallon of finished formulation per acre. Dipel 4L was mixed with water and a sticker (Acrylocoat®) 1/ in the following volumetric proportions:

Dipel 4L	25 percent
Acrylocoat	3 percent
Water	72 percent

The Acrylocoat was used to increase the rain-resistance of the B.t. formulation. A total of 79 stands (spray blocks) containing 1,714 ac (694 ha) of hemlock and 643 ac (260 ha) of white spruce were treated. These stands ranged in size from 7 to 247 acres (3 to 100 ha) with an average spray block size of 37 acres (15 ha).

Nine drum samples of Dipel were taken at the airport and sent to the USDA Research Center in Brownsville, Texas for bioassay.

A Thrush Commander equipped with standard spray booms was used to apply the material. Fifty-three 8004 flat fan Tee-Jet® 2/ nozzles directed 90° downward provided an effective swath width of 100 ft. (30.4 m) when the plane was flown at an air speed of 110 mph (177 km/h) approximately 50 feet (15.2 m) above the canopy. The D-Max method (Maksymiuk 1964), recently tested for water-base sprays by Ciesla and Livingston (1980), was used for calibration. Eight ounces of green food coloring per 30 gallons of formulation was added during calibration to enhance deposit visibility on white Kromekote® 3/ cards. Orientation flights were made to familiarize the pilots and observers with the treatment blocks. A guide plane with one observer was used to assist the spray pilot in maintaining accurate orientation and spray deposition.

1/ Acrylocoat is the registered trade mark of Rohm and Haas Company.
2/ Tee Jet is the registered trade mark of Spraying Systems Company.
3/ Kromekote is the registered trade mark of Champion Paper Company.

To assess the effectiveness of the treatment, pre- and postspray sampling of spruce budworm larvae was done in twelve compartments. Six sampling locations were in hemlock type and six in white spruce type. Four locations, two each of white spruce and hemlock, were used as untreated check blocks. These samples were taken 1 to 4 days prespray and 15 to 19 days postspray.

A total of nine dominant or codominant host trees were sampled in each compartment, three clusters of three trees each for a total of 108 samples. A single 15-inch (38 cm) midcrown branch tip was collected from each of the sample trees using a pole pruner with attached basket. The branches and associated insects were individually bagged in appropriately labeled brown paper sacks. The samples were later examined for spruce budworm larvae in the laboratory at Toumey Nursery, Ottawa National Forest, Watersmeet, Michigan. The number of larvae found on each sample was recorded according to host, treatment, and survey period (ie., prespray or postspray).

To properly time the application of the material, developmental samples of the budworm larvae were taken. Developmental sampling began on May 20, 1981, and continued through May 31, the day application was completed. Separate developmental samples were taken for hemlock and white spruce.

Aerial release of Dipel 4L began when budworm larvae were at the peak (76 percent) of the third instar on hemlock and, two days beyond the peak of the third instar on white spruce. This timing was selected because early instars are reputed to be more vulnerable to B.t., the insects were feeding on expanding needles, and the hemlock was the more important target.

Meteorological conditions during periods of B.t. application were:

Temperature - 55°F to 70°F (13°C to 21°C)
Relative humidity - 50 percent or above
Wind - 2-8 mph (3.2 to 12.8 km/h)

There was no rain for at least 48 hours after the B.t. was applied.

Three days following release, the same twelve compartments were sampled for the presence of B.t. Five twig samples containing at least 20 needles were taken at each sample site. In the laboratory, needles were removed and incubated on tryptocase soy agar at 23°C for three days to determine if viable B.t. was present. The percent of needles producing B.t. colonies was recorded for each compartment.

Defoliation was evaluated in August, 1981 at the same twelve sample sites. The nine trees used for larval sampling plus 21 other host trees were sampled at each site. One branch tip was cut (pole pruner) from the midcrown of each sample tree and the 12 most distal new shoots classified according to percent foliage retained. Dead buds, caused by prespray budworm mining, were given a foliage retention value of zero because all foliage was lost on that shoot. Thus, all 1981 defoliation,

both prespray and postspray, was included in evaluating and summarizing the defoliation in each compartment.

RESULTS

The B.t. treatment killed 57 percent of spruce budworm on hemlock and 13 percent of the budworm on white spruce. These mortality percentages were corrected by Abbott's (1925) formula to account for natural mortality. The number of budworm larvae per 15-inch branch after B.t. release was 0.53 on hemlock and 2.44 on white spruce (Table 1).

Table 1.--Number of spruce budworm larvae, pre- and post- B.t. release, per 15-inch branch tip. Nicolet National Forest, 1981.

Tree Species	Treatment	Pre-release	Post-release
Hemlock	B.t.	1.39	0.53
	check	1.83	1.61
White Spruce	B.t.	8.75	2.44
	check	11.39	3.61

The percentage of needles retained on 1981 shoot growth was not affected by B.t. release. (Table 2). Hemlock retained a greater amount of new foliage than white spruce, but both tree species had more than the 60 percent foliated shoots needed to maintain growth.

Table 2.--A summary of hemlock and white spruce foliage retention, Nicolet National Forest, 1981.

Tree Species	Treatment	Percent Foliage
Hemlock	B.t.	97
	check	90
White Spruce	B.t.	77
	check	70

The results of the bioassays of the drum samples showed no significant differences in B.t. potencies between drums.

Evaluation of post-release spray deposit coverage indicated target spray areas and check plots were positive for B.t. (Table 3). Spray plots averaged 49 percent of the needles covered with a range from 19 to 82 percent. Check plots averaged 11.25 percent with a range from 5 to 15 percent.

Table 3.--Needles producing B.t. colonies following incubation on tryptocase soy agar at 23° C, in the dark, for 3 days.

B.t. Plots		Check Plots	
Plot Number	Percent	Plot Number	Percent
12	6	3	5
24	80	126	10
32	82	197	16
71	35	208	14
123	19		
150	57		
151	20		
177	28		

DISCUSSION AND RECOMMENDATIONS

An unknown factor caused drastic reductions in the budworm population over a wide area about the time that the majority of the larvae were reaching the sixth instar. This complicated the evaluation of not only budworm mortality, but also foliage protection because white spruce continued to foliate beyond the time of collapse. Consequently, there was an abundance of foliage present when the defoliation sampling was completed.

Hemlock foliage seemed full and healthy in all stands, both those that were untreated as well as those that were treated with B.t. Some trees that were in poor condition from past defoliation showed signs of recovery. White spruce produced good shoot length in the top, but many lower brances died on trees severely defoliated in the past. Both hemlock and white spruce stands should be monitored by Forest personnel for signs of root rot, bark beetles, and wood borers for the next three to five years.

Although larval populations were not reduced to acceptable levels on white spruce, the trees were only moderately defoliated. Plentiful soil moisture and the white spruce's inherent ability to recover from defoliation probably account for the good growth attained in spite of the continued defoliation caused by surviving budworm larvae.

Analysis of foliage protection data was confounded by the apparent collapse of budworm populations. Thus, it is difficult to make authoritative recommendations on the use of this pesticide for foliage protection. Results of the post spray larval sampling revealed, however, that B.t. was not effective in reducing populations to the desired level on white spruce. This may have been due to the

differences in phenology of hemlock and white spruce. The timing of B.t. release favored the foliar development of hemlock. If the release had been delayed a few days, bud cap drop and shoot development of the white spruce would have progressed and the B.t. might have been more effective. This aspect of timing should be considered in the future, if B.t. is to be used on white spruce.

Some difficulties were encountered in mixing the Acrylocoat with the rest of the tank mix. The Acrylocoat cannot be mixed directly with undiluted Dipel because the mixture congeals and will not dissolve in water. Some difficulty was also experienced when the Acrylocoat was added, undiluted, to the tank mix. Lumps of undissolved Acrylocoat and fragments of dried Acrylocoat film caused serious nozzle clogging problems. The following procedure provided good mixing and minimized the problems associated with film from solidified Acrylocoat:

1. The required volume of Acrylocoat was thoroughly mixed with an equal part of water.

2. The diluted Acrylocoat was then filtered through a piece of window screen to remove lumps and pieces of film that could clog nozzles.

3. The diluted and "filtered" Acrylocoat was slowly added to the tank mix of water and Dipel 4L with constant agitation.

4. The amount of water needed in the formula was reduced to allow for water used in diluting the Acrylocoat.

The positive B.t. results obtained in the check plots were confusing. Similar results for nonsprayed areas in a previous budworm suppression project were attributed to drift from nearby treated areas (Millers 1980). However, in no case were the check areas in the vicinity of a treatment area. Therefore, the likelihood of drift into these points seems remote.

Following the completion of our analysis, Dick Reardon reported (1981) 1/ large amounts of a variety of B.t., different than that used in commercial insecticides (B. thuringensis var. kurstaki), on spruce and hemlock foliage in northern Wisconsin. The bacterium is currently being identified and will be tested for pathogenicity on the spruce budworm.

Reardon's findings may explain the positive B.t. results in unsprayed areas. Our methods were not capable of separating kurstaki from other varieties. Therefore, the positive results in such areas may well reflect the presence of an as yet unidentified native variety and not a residue resulting from the release project.

1/ Personal communications, Research entomologist, Pacific Southwest Forest and Range Experiment Station, Davis, California.

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